

Polarized Electrons at Surfaces by J. Kirschner. 158 pages with references and index. 57 figures (ISBN 3-540-15003-X Springer-Verlag, Berlin, Heidelberg, New York, Tokyo). 9-3/4 x 6-3/4 inches hardbound. Price
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The application of electron spin polarization in the study of surfaces is a very exciting and rapidly growing research area. This monograph gives the author's incisive and up-to-date (as of 1984) view of the field. The book has four main parts: Basic Concepts, Experimental Considerations, Results from Non-Magnetic Crystals, and Results from Magnetic Materials. The book is sufficiently self-contained to provide an introduction to the field, for students at the graduate level, for example, as well to serve as a useful reference work.

The chapter on Basic Concepts introduces the definition of degree of spin polarization and uses the density matrix formalism to describe a partially polarized beam. The two important spin dependent interactions, the exchange interaction and the spin orbit interaction are described briefly. The first part of this chapter appears to be intentionally succinct so as not to duplicate the very nice introduction into the basic concepts of electron spin polarization found in the book Polarized Electrons by J. Kessler (Springer-Verlag, 1976, 2nd ed., 1985) which would be excellent complementary reading for someone new to the field. The rest of the chapter establishes the theoretical framework in terms of which the polarized electron diffraction and

spin polarized photoemission results of later chapters are discussed. The section on polarized low energy electron diffraction (LEED), including a discussion of time reversal and spatial symmetries, is very good. A general treatment of spin polarized photoemission is presented which is suitable for either magnetic or nonmagnetic systems. It discusses the origin of spin polarization effects in the initial state, the final state, or in the operator for photoexcitation. A short discussion of inelastic electron scattering is also included.

The chapter on Experimental Considerations discusses detectors of polarized electrons and sources of polarized electrons. The emphasis is on the LEED detector developed by the author as an alternative to the traditional high energy scattering Mott detector described, for example, in Kessler's book. The principles and characteristics of the GaAs spin polarized electron source are presented. Photoemission from negative electron affinity GaAs is now the most widely used source of spin polarized electrons. The author's enthusiasm for use of a visible (He-Ne) laser, which requires using a ternary compound such as GaAlAs or GaAsP to match the bandgap to the laser, may mislead the reader. Others, including this reviewer, find the high power, compact diode lasers with the matching optics which are now readily available to be superior. The diode lasers can be obtained either pulsed or cw at the correct wavelength for photoexcitation of electrons in GaAs. In addition, the smaller negative electron affinity of GaAs yields an electron beam of a 200 meV FWHM for an optimally activated cathode compared to a 800 meV FWHM for GaAsP. The next chapter, Results from Non-Magnetic Crystals, illustrates how spin dependent measurements provide new information and insight into several aspects of spin polarized low energy electron diffraction: symmetry

relations, analysis of surface atomic structure, surface resonances at beam emergence thresholds, temperature effects, and the effect of adsorbates. The second part of the chapter is devoted to the area pioneered by the author, momentum and spin resolved photoemission from non-magnetic materials. Nice examples are presented where the origin of the spin dependent photoemission lies (i) in the optical selection rules (operator effects) and (ii) in the spin-orbit interaction in the LEED state (final state effects).

In the chapter on results from magnetic materials, spin dependent electron scattering is seen to arise from the spin orbit interaction, the exchange interaction, and even the interference between the two. It is shown that by isolating the spin dependence due to the exchange interaction, magnetic properties of surfaces can be investigated, as illustrated by the measurement of low temperature surface spin deviations and the measurement of the critical scattering exponent as the temperature approaches the Curie temperature. Some of the pitfalls which may be encountered in polarized electron scattering from magnetic materials are discussed. A measurement of the spin dependent asymmetry of inelastically scattered electrons to determine the spectrum of Stoner excitations is also presented. Applications of spin polarized secondary emission, Auger emission, photoemission and inverse photoemission are described. These range from obtaining element specific information on local magnetic moments via spin polarized Auger emission to the temperature dependence of exchange split bands observed by spin polarized photoemission and inverse photoemission.

The book is written in a pleasant informal style. There are many cases where extra effort is made to add physical insight to the discussion. The publisher did a poor job of editing this book which suffers from several dozen typographical errors and cases of unconventional use of language. Fortunately, none of the errors, including typos in Eqs. 2.58, 2.59, and 3.1 and some confusion about numbering of figures in the second chapter, is such as to mislead the careful reader.

As stated in the preface, this book is based largely on a "Habilitationsschrift" which characteristically is a presentation of one person's scientific work to qualify for a certain level in the German academic system. Thus about sixty percent of the illustrations involving experimental data are from the author's own work. Consequently the book does not reflect the balance that might be expected from an introductory reference work in a field. Nevertheless, owing in part to the many contributions of the author to different aspects of polarized electrons at surfaces, and in part to the additional references which should allow the reader to trace down other work in the field, this lack of balance does not seriously detract from the usefulness of the book.